

### **REMARKS**

#### **Claim Summary**

Claims 38-54 and 67-68 have been withdrawn from consideration. Claim 37 has been rejoined. Claims 37 and 55-66 are rejected, while the Examiner objects to claim 55. Claims 37 and 55 are amended. Therefore, claims 37-66 are all the claims pending in the application.

#### **Formal Matter**

With the Office Action dated May 13, 2009, the Examiner accepted the drawings filed July 30, 2006 and May 30, 2008, and returned a signed copy of the PTO forms submitted with the July 12, 2006 Information Disclosure Statement. Applicants thank the Examiner for indicating that all the references listed therein have been considered. Applicants additionally thank the Examiner for acknowledging the claim to foreign priority and the receipt of the certified copy of the priority documents submitted July 12, 2006.

#### **Claim Objections**

Claim 55 is objected to under 37 C.F.R. § 1.75(c), as being of improper dependent form. In particular, the Examiner asserts that claim 55 is a dependent process claim based on the product claim 37, therefore fails to further limit the subject matter of claim 37. In response, claim 55 has been rewritten into independent form encompassing all the limitations of claim 37. Withdrawal of the objection is respectfully requested.

#### **Claim Rejections - 35 USC § 103**

Claims 37, and 55-66 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Kawano (JP 2003-17420, hereinafter "Kawano").

With respect to claim 37, the Examiner alleges that the first gallium nitride system compound semiconductor layer disclosed by Kawano corresponds to the claimed higher concentration layer of claim 37, and a second gallium nitride system compound semiconductor

layer corresponds to the lower concentration layer of claim 37. However, the Examiner acknowledges that Kawano fails to disclose a “repetition number of [the] higher concentration layer and [the] lower concentration layer is 10 to 1000”, as recited in claim 37.

To make up for this deficiency, the Examiner asserts that Kawano discloses a repetition of the first and second gallium nitride system compound semiconductor layers through gallium nitride system compound semiconductor layers three and four (paragraphs [0039]-[0042]), and alleges that it would have been obvious to have a repetition number between 10 to 1000 repetitions to yield predictable results.

Applicants traverse this rejection as follows.

The present invention provides a Group III nitride semiconductor light-emitting device having a low forward voltage. As stated on page 16 of the specification, a low forward voltage may be obtained by controlling the thickness of the n-type impurity concentration periodic variation layer. Such a thickness is defined by reciting the repetition number of the higher concentration layer and the lower concentration layer. More specifically, since “the repetition number of [the] higher concentration layer and [the] lower concentration layer is 10 to 1000”, as recited in claim 37, pits formed in the higher concentration layer are filled up with a portion of the lower concentration layer, and an n-type Group III nitride semiconductor layered structure having low resistance and high flatness is obtained (page 9, lines 20 to 29).

On the other hand, Kawano discloses a gallium nitride substrate comprising four layers, where the first and third layers are gallium nitride system compound semiconductor layers having a silicon doping of  $1 \times 10^{19}$  per cubic centimeter ( $\text{cm}^{-3}$ ) or higher, and the second and the fourth layer are gallium nitride system compound semiconductor layers having a silicon doping of  $1 \times 10^{19} \text{ cm}^{-3}$  or lower (Paragraphs [0010]-[0011]). Kawano further discloses that Si and Ge

doping are interchangeable (Paragraph [0026]). The first gallium nitride system compound semiconductor layer having a silicon doping of  $1 \times 10^{19} \text{ cm}^{-3}$  or higher has an island-like structure and the second gallium nitride system compound semiconductor layer having a silicon doping of  $1 \times 10^{19} \text{ cm}^{-3}$  or lower is formed thereon. Kawano discloses that if the first and second gallium nitride system compound semiconductor layers are repeated twice or more, then threading dislocation<sup>1</sup> can be reduced (Paragraph [0012]). As a result, adjacent islands are combined and form a loop to reduce threading dislocations (paragraph [0010]-[0012]). Therefore, the object and means of the exemplary embodiments recited in claim 37 are different from Kawano, because Kawano at no point discloses or suggests “pits being provided on a surface of the higher concentration layer” and instead discloses that adjacent islands are combined and form a loop to reduce threading dislocations.

Furthermore, Kawano at no point discloses or suggests that “a thickness of a repetition cycle is 1 nanometer (nm) to 1000 nm”, as recited in amended claim 37. (see specification page 15, lines 15 to 18). Instead, Kawano discloses in paragraph [0027] that the thickness of the first gallium nitride system compound semiconductor layer should be 5 micrometers ( $\mu\text{m}$ ) (5000 nm) or more, and preferably 15  $\mu\text{m}$  (15,000 nm) or more in order to broadly bend threading dislocation. Kawano also discloses that the thickness of the second gallium nitride system compound semiconductor layer should be 5  $\mu\text{m}$  (5000 nm) or more, and preferably 15  $\mu\text{m}$  (15,000 nm) or more so that a loop is formed to reduce threading dislocations. Accordingly, the sum of the thickness of the first gallium nitride system compound semiconductor layer and that of the second gallium nitride system compound semiconductor layer is 10  $\mu\text{m}$  (10,000 nm) or

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<sup>1</sup> The machine translation of Kawano incorrectly refers to “penetration transposition,” whereas “threading dislocation” is an accurate translation.

more, and preferably 30  $\mu\text{m}$  (30,000 nm) or more. Therefore, independent claim 37 is patentable over Kawano because Kawano fails to disclose “a thickness of a repetition cycle is 1 nanometer (nm) to 1000 nm”, as recited in amended claim 37.

Independent method claim 55 contains all of the limitations of product claim 37. Therefore, claim 55 is patentable over Kawano for the same reasons as set forth above with regard to claim 55.

Dependent claims 56-62 are patentable at least by virtue of dependency from claim 55.

Dependent claims 63-66 are patentable by virtue of dependency from claim 55, as well as for their additional recited features.

With respect to claims 63 and 64, the Examiner asserts that Kawano fails to disclose all the features of these claims, but alleges that it is well known and common knowledge to set the growth speed of the second gallium nitride system compound semiconductor layer different from the growth speed of the first gallium nitride system semiconductor layer. Similarly, with respect to claims 65 and 66, the Examiner acknowledges that Kawano fails to disclose a nitrogen/III ratio in the growth of the second gallium nitride system compound semiconductor layer that is different from the nitrogen/III ratio in the first gallium nitride system compound semiconductor layer, but alleges it is well known and common knowledge in the art to optimize the gas ratio of specific processes to meet the desired process of specific parameters.

However, a particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges thereof might be characterized as “routine experimentation,” (MPEP § 2144.05). In this case, the Examiner has pointed to nothing in Kawano which suggests a growth speed of the second gallium nitride system compound semiconductor layer different from the

growth speed of the first gallium nitride system compound semiconductor layer, or a nitrogen/III ratio in the growth of the second gallium nitride system compound semiconductor layer different from the nitrogen/III ratio in the first gallium system compound semiconductor layer. Thus, it is unclear how the Examiner could reasonably conclude that the subject matter of claims 63-66 relates to art-recognized result-effective variables.

Further, the Examiner states that Kawano does not specifically disclose the process wherein the growth rate of the second gallium nitride system compound semiconductor layer is different from the growth rate of the first gallium nitride system compound semiconductor layer. However, paragraph [0031] of Kawano discloses that the growth rates of both the first gallium nitride system compound semiconductor layer and the second gallium nitride system compound semiconductor layer are preferably equal. Kawano discloses that when the growth rates between the first and second gallium nitride system compound semiconductor layers are different, a strain is generated in an interface due to a difference in the crystallinity between the layers. Therefore, having equal growth rates between the first and second gallium nitride system compound semiconductor layers reduces such a strain.

### **Conclusion**

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



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